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For: Methods For Producing Potato Products

CLAIM TO CONVENTION PRIORITY UNDER 35 U.S.C. 119

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In the matter of the above-identified application and under the provisions of 35 U.S.C. 119 and 37 C.F.R. 1.55, Applicant(s) claim priority of Danish application no. PA 200 00623 filed on April 14, 2000. Applicant submits a duly certified copy of said foreign application.

Respectfully submitted,

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Patent application No.: PA 2000 00623

Date of filing: 14 April 2000

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This is to certify the correctness of the following information:

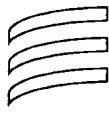
The attached photocopy is a true copy of the following document:

- The specification, claims and abstract as filed with the application on the filing date indicated above.

By assignment dated 17 Nov 2000 and filed on 01 Dec 2000, the application has been assigned to Novozymes A/S



Patent- og
Varemærkestyrelsen
Erhvervsministeriet



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PVS

PROCESS FOR PRODUCING FRIED POTATO PRODUCTS

TECHNICAL FIELD

The present invention relates to a method for producing frozen or fried potato products. More particularly, the invention relates to a process for increasing the crispiness after frying of such potato products.

BACKGROUND OF THE INVENTION

For fried potato products such as fried potato strips, e.g. french fries, and potato chips it is important that the product is perceived as crispy by the consumer. Also the fat content is important as the consumer concern about dietary fat levels increases. Several methods for improving the crispiness of french fries and/or lowering the fat content has been described in the prior art, including e.g. blanching, addition of enzymes, such as alpha-amylase, and/or coating the potato pieces prior to frying, cf., e.g., US 4,503,127; US 4,058,631; GB 1,278,736; Effect of Preheating on Potato texture by A. Andersson et al., Critical Reviews in Food Science and Nutrition, 1994, 34 (3; 229-251); and US 5,965,189.

There is a need for an improved process for the manufacturing of fried potato, such as a process for improving the crispiness of the resulting product.

SUMMARY OF THE INVENTION

The invention relates to a process for producing a potato product, e.g. fried or frozen french fries and potato chips. There is provided a process for improving the properties of such potato products; in particular the crispiness is improved by the present invention. The inventors have found that enzyme treatment with pectin methylesterase of french fries prior to frying significantly increases the crispiness after frying. Accordingly, the invention relates to a process for processing potatoes, wherein to the potato material is treated with a pectinase, including e.g. pectin methylesterase. The invention also relates to a process for the production of a potato product, such as potato chips or french fries, which, when fried ready for consumption, retain their surface crispiness and/or rigidity for a longer period of time

after finished frying. The invention further relates to a process comprising the steps of blanching potato pieces; followed by treating the blanched potato pieces with pectinase, such as pectin methylesterase. In a further aspect the invention provides a process comprising the steps of: (i) treating a potato batter or a potato dough with 5 pectinase, such as pectin methylesterase; and (ii) processing the potato batter or potato dough into potato pieces of a desired shape.

The invention also relates to the use of pectinase, including pectin methylesterase, in the manufacturing of potato products as described herein, wherein the pectinase 10 treatment is conducted by addition of the enzyme to the potato material prior to frying. The invention further relates to the use of pectinase, e.g. pectin methylesterase, for the manufacturing of an enzyme preparation for use in potato processing. The invention also relates to potato products obtainable, in particular obtained, by any of the processes described herein.

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DETAILED DISCLOSURE OF THE INVENTION

The present invention relates to a method for processing potato to manufacture a potato product, the method comprising the step of treating potato pieces with pectin methylesterase.

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In accordance with the present invention it has been found that when potato pieces is treated with pectin methylesterase, such as by contacting the surface of potato pieces with an aqueous solution of pectin methylesterase prior to frying, the crispiness of the fried product is improved.

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The starting material and product of the invention:

French fried potato strips, commonly referred to as french fries, served in most fast food restaurants and other food service institutions, are commonly purchased by the restaurant in bulk from commercial suppliers in the form of partially fried (par-fried) 30 and frozen potato strips which are stored in frozen condition until shortly before serving. At that point the par-fried potato strips are prepared for consumption by e.g. frying in fat or oil.

In the process of this invention, the potato pieces may be obtained from crude potatoes of a variety known to be suitable, e.g. for preparing french fries. The potatoes may be washed, peeled and trimmed in accordance with conventional practice and cut into strips of a desired size and shape, e.g. for french fries such as shoestring potato strips, crinkle-cut strips, and straight cut thick strips. As an example, the strips may have a width and thickness of from about 5 mm to about 15 mm and several cm's in length. After cutting, the strips may be washed to remove surface starch. Accordingly, the potato pieces may be obtained by dividing potatoes (such as by cutting), into strips, slices or any other forms/shapes, e.g. in the form of elongated potato strips. The potato pieces may also be obtained from a potato dough or potato batter which is subsequently formed into the desired shape.

The invention relates to the potato products obtainable or obtained by the process of the invention. The product of the invention may, e.g., be a fried potato product ready for consumption or it may be a frozen potato product which is to be sold as such with the intention that the product subsequently is made ready to eat. Within the scope of the invention is thus also an oven baked potato product or a fried potato product obtained or obtainable by the process as described herein. The product may e.g. be french fries or potato chips.

The enzymatic treatment:

- In the present context by the term "treatment with enzyme", such as treatment with pectin methylesterase, is understood the enzymatic activity is provided by a non-endogenic pectin methylesterase, as opposed to the enzymatic activity which may be provided by the presence of endogenic pectin methylesterase in the potatoes. In the context of the present invention, by "endogenic" pectin methylesterase is meant the presence in the potatoes after harvest of a native potato pectin methylesterase enzyme and where the pectin methylesterase enzyme present in the potatoes is the result of expression of a native potato pectin methylesterase gene present in the potato plant.

The term "treatment" or "treating" with pectin methylesterase encompasses *addition* of pectin methylesterase enzyme to the potato pieces. The pectin methylesterase added to the potato pieces may be any kind of pectin methylesterase enzyme as described herein and may be in any form, such as in the form of an aqueous solution 5 comprising pectin methylesterase etc.. Thus, the term treatment with pectin methylesterase also includes treatment with a native potato pectin methylesterase provided that the potato native pectin methylesterase is *added* to the potato pieces, e.g. in the form of a substantially pure or an essentially pure potato pectin methylesterase enzyme preparation. The term "substantially pure" or "essentially 10 pure" in the context of a "pectin methylesterase *enzyme preparation*" has the same meaning as the terms a "substantially pure pectin methylesterase" or an "essentially pure pectin methylesterase", respectively, as defined herein.

The process of the present invention, encompasses treatment with an exogenic 15 pectin methylesterase. By the term "exogenic" is meant that the pectin methylesterase treatment of the potato pieces is provided by *addition* of pectin methylesterase. For the term "exogenic" treatment with pectin methylesterase as used herein, the pectin methylesterase is not provided by the presence in the potatoes after harvest (from which the potato pieces has been made) of a pectin 20 methylesterase enzyme which is the result of expression of a pectin methylesterase gene present in the potato plant. The term exogenic as used herein thus means that the enzyme has not been produced in the substrate to be treated with the enzyme, i.e. in the present context the term refers to whether the enzyme is produced in the potatoes to be treated or not, the later situation being termed exogenic.

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The process of the invention may further to the treatment with pectin methylesterase also encompass a step wherein the endogenic pectin methylesterase enzyme is activated, however, the basis of the process of the invention is the improvement as described herein provided by the *treatment* with a non-endogenic pectin 30 methylesterase.

Accordingly, the process of the invention relates to a process comprising the step of treating potato pieces with pectin methylesterase, wherein the pectin methylesterase is added to the potato pieces, such as in the form of a pectin methylesterase enzyme preparation.

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By the term "treatment with pectin methylesterase" in the context of the present invention, is understood that the enzyme is present in an effective amount and under appropriate conditions (such as, e.g. temperature and pH) so that by the enzyme treatment of the potato material there is provided the desired effect as described 10 herein.

Thus, the enzymatic treatment in the process of the invention may be conducted by contacting the surface of the potato pieces with an effective amount of pectin methylesterase and allowing the enzyme reaction to take place at an appropriate 15 holding-time at an appropriate temperature. The treatment with pectin methylesterase may be carried out at conditions chosen to suit the selected enzymes according to principles well known in the art.

In further embodiments the treatment of the potato pieces with pectin methylesterase 20 is provided by a pectin methylesterase enzyme preparation. By the term "pectin methylesterase enzyme preparation" is meant any preparation comprising one or more pectin methylesterase, which preparation is contacted with the potato material to provide the desired enzymatic effect as described herein. Accordingly, the pectin methylesterase treatment in the process of the invention may be performed by 25 contacting the potato pieces with a pectin methylesterase enzyme preparation, e.g. in the form of an aqueous solution comprising pectin methylesterase. The pectin methylesterase preparation may be one which comprises pectin methylesterase as the major enzymatic component, e.g. a mono-component enzyme preparation or the pectin methylesterase preparation may comprise a mixture of pectin methylesterase 30 or a mixture of one or more pectin methylesterase(s) and other enzymes.

Accordingly, the pectin methylesterase treatment may be performed by incubating

the potato pieces with pectin methylesterase, e.g. by immersion the potato pieces into a preparation comprising the pectin methylesterase or by means of spray equipment.

- 5 As described herein, the potato pieces may be provided by dividing potatoes into pieces by cutting. In further embodiments, the potato pieces are prepared from potato batter or potato dough (as opposed to e.g. potato pieces obtained by cutting whole potatoes into strips) and then the pectin methylesterase treatment may be performed contacting the outer surface of the potato pieces with the enzyme and/or
- 10 by mixing pectin methylesterase into the potato batter or potato dough before shaping it into potato pieces in the form of e.g. french fries.

Enzymes to be used in the process of the invention:

While the invention has been particularly described with respect to the pectin methylesterase, it is contemplated that other pectin modifying enzymes (pectinases) may be used as well, the term pectin used in this context is to be understood in its broadest sense, also called pectic substances. The enzyme used in the process of the present invention includes any enzyme with activity towards pectic substances, such enzymes are also termed pectinases, e.g. enzymes having pectin methylesterase activity. In the process of the invention, the pectinase treatment may be provided by one or a more pectinases, such as two or more pectinases, of the same type (e.g. two different pectin methylesterase) or of different types (e.g. a pectin methylesterase and an arabinanase). Thus, the treatment may be provided by monocomponent pectinase or a mixture of pectinases. The pectin methylesterase treatment may be provided by one or a more pectin methylesterases, such as two or more pectin methylesterases. The pectinase covers enzymes modifying pectic substances. Pectic substances comprises homogalacturonans, xylogalacturonans and rhamnogalacturonans including sidechains attached to either of these. Thus, the invention relates to treatment of potato pieces with a pectinase which is capable of providing the effect as described herein (such as increasing the crispiness of the french fries ready for consumption) and being exemplified herein with a pectin methyl esterase.

Pectin methylesterase (PME), also called pectinesterase (PE), pectin demethoxylase and pectin methoxylase, is defined according to standard enzyme EC-classification as EC 3.1.1.11. (Enzyme Nomenclature 1992, Academic Press, Inc., 1992). Pectin 5 methylesterase converts high-methoxylated pectin to low-demethoxylated pectin.

The pectinase may, as an example, be selected from the group consisting of pectin methylesterase (catalyses the removal of methanol from pectin, resulting in the formation of pectic acid, polygalacturonic acid), pectin acetylesterase (catalyses the 10 removal of acetyl groups from acetylated pectin), rhamnogalacturonan acetylesterase (catalyses the removal of acetyl groups from acetylated rhamnogalacturonans), arabinanase (catalyses the degradation of arabinan sidechains of pectic substances), galactanase (catalyses the degradation of arabinogalactan and galactan sidechains of pectic substances), arabinofuranosidase (removes arabinosyl substituents from 15 arabinans and arabinogalactans), rhamnogalacturonase and rhamnogalacturonan lyase (degrades rhamnogalacturonans), pectate lyase (cleaves glycosidic bonds in polygalacturonic acid by beta-elimination), pectin lyase (cleaves the glycosidic bonds of highly methylated pectins by beta-elimination), and polygalacturonase (hydrolyses the glycosidic linkages in the polygalacturonic acid chain).

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The pectinase, including the pectin methylesterase, may be of any origin, e.g. of animal origin (such as, e.g. mammalian), or snake venom or bee venom or from plants. Alternatively, the pectinase, such as e.g. the pectin methylesterase, may be of microbial origin, e.g. from filamentous fungi, yeast or bacteria, such as the genus or 25 species *Aspergillus*, e.g. *A. niger* *A. aculeatus*, *A. awamori*, *A. foetidus*, *Asp. japonicus*, or *A. oryzae*; *Dictyostelium*, e.g. *D. discoideum*; *Mucor*, e.g. *M. javanicus*, *M. mucedo*, *M. subtilissimus*; *Neurospora*, e.g. *N. crassa*; *Rhizomucor*, e.g. *R. pusillus*; *Rhizopus*, e.g. *R. arrhizus*, *R. japonicus*, *R. stolonifer*; *Sclerotinia*, e.g. *S. libertiana*; *Trichophyton*, e.g. *T. rubrum*; *Whetzelinia*, e.g. *W. sclerotiorum*; *Bacillus*, 30 e.g. *B. megaterium*, *B. subtilis*; *Citrobacter*, e.g. *C. freundii*; *Enterobacter*, e.g. *E. aerogenes*, *E. cloacae* *Edwardsiella*, *E. tarda*; *Erwinia*, e.g. *E. herbicola*; *Escherichia*, e.g. *E. coli*; *Klebsiella*, e.g. *K. pneumoniae*; *Proteus*, e.g. *P. vulgaris*; *Providencia*,

e.g. *P. stuartii*; *Salmonella*, e.g. *S. typhimurium*; *Serratia*, e.g. *S. liquefasciens*, *S. marcescens*; *Shigella*, e.g. *S. flexneri*; *Streptomyces*, e.g. *S. violeceoruber*; *Yersinia*, e.g. *Y. enterocolitica*, e.g. *Pyrenomycetes*, such as the genus *Fusarium*, such as a strain of *F. culmorum*, *F. heterosporum*, *F. solani*, or a strain of *F. oxysporum*. In one embodiment the pectinase, e.g. the pectin methylesterase, is of fungal origin, such as a pectin methylesterase derived or obtained from *Aspergilli*, such as *Aspergillus Niger* or *A. aculeatus*.

The enzyme used in the process of the invention may be derived or obtainable from any source, including those mentioned herein.

The term "derived" means in this context that the enzyme may be provided from an organism where it is present natively, i.e. the identity of the amino acid sequence of the enzyme are identical to a native enzyme. The term "derived" also means that the enzymes may have been produced recombinantly in a host organism, the recombinant produced enzyme having either an identity identical to a native enzyme or having a modified amino acid sequence, e.g. having one or more amino acids which are deleted, inserted and/or substituted, i.e. a recombinantly produced enzyme which is a mutant and/or a fragment of a native amino acid sequence. The host organism may be an organism native to the enzyme in question or it may be a non-native organism. Within the meaning of a native enzyme are included natural variants. An enzyme having an amino sequence corresponding to that of a native enzyme is also called wildtype. Furthermore, the term "derived" includes enzymes produced synthetically by e.g. peptide synthesis. The term "derived" also encompasses enzymes which have been modified e.g. by glycosylation, phosphorylation etc., whether in vivo or in vitro.

The term "obtainable" in this context means that the enzyme has an amino acid sequence identical to a native enzyme, i.e. wildtype. The term encompasses an enzyme that may be obtained from an organism where it is present natively, or one in which it has been expressed recombinantly in the same type of organism or another, or enzymes produced synthetically by e.g. peptide synthesis. With respect to

recombinantly produced enzyme the terms "obtainable" and "derived" refer to the identity of the enzyme and not the identity of the host organism in which it is produced recombinantly.

- 5 Accordingly, the enzyme used in the process of the invention, e.g. pectin methylesterase, may be obtained from a microorganism by use of any suitable technique. For instance, a pectin methylesterase enzyme preparation may be obtained by fermentation of a suitable microorganism where it is present naturally (i.e. a native pectin methylesterase) and subsequent isolation of a pectin
10 methylesterase preparation from the resulting fermented broth or microorganism by methods known in the art, e.g. by liquid chromatography such as ion exchange, gel filtration or affinity chromatography. The isolating of the enzyme may be more or less crude, i.e. the enzyme may be more or less purified. The pectin methylesterase may also be obtained by use of recombinant DNA techniques. Such method normally
15 comprises cultivation of a host cell transformed with a recombinant DNA vector comprising a DNA sequence encoding the pectin methylesterase in question and the DNA sequence being operationally linked with an appropriate expression signal such that it is capable of expressing the pectin methylesterase in a culture medium under conditions permitting the expression of the enzyme and recovering the enzyme from
20 the culture. The DNA sequence may also be incorporated into the genome of the host cell. The DNA sequence may be of genomic, cDNA or synthetic origin or any combinations of these, and may be isolated or synthesized in accordance with methods known in the art. In one embodiment of the invention the pectinase, such as the pectin methylesterase, is obtained by using a host system for the expression of
25 the enzyme which does not produce any pectin depolymerizing enzymes, cf. e.g. WO 94/25575.

In one embodiment of the invention, the pectin methyl esterase used in the process of the invention is essentially free from pectic depolymerizing enzymes.

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In the following are given some examples of specific pectinases. Several pectin methylesterases are disclosed in US 5,707,847; S. Ishii et al., 1979, Journal of Food

- Science 44, p 611-614; EP 0 388 593 A1; EP 0 388 593 A1; DE 2843351; and US 4,200,694. Suitable pectin methylesterases are available commercially, e.g. NovoShape™ (Novo Nordisk A/S. Rhamnogalacturonase and rhamnogalacturonan lyase are described in: Kofoed et al., 1994, The Journal of Biological Chemistry, Vol 269, No 46, pp 29182-29189. Rhamnogalacturonan acetylesterase are described in: Kofod et al., 1995, The Journal of Biological Chemistry, Vol 270, NO 45, pp 27172-27178. Arabinanase is disclosed in WO 94/20611 and galactanase is disclosed in: Christgau et al., 1995, Current Genetics, vol 27, pp 135-141. Arabinofuranosidase is described in Beldman G. et al., 1993, Carbohydrate Polymers, Vol 20, pp 159-168.
- 10 Polygalacturonase is disclosed in WO 94/14952 and pectin lyase in US 5,858,760.

In one embodiment, the pectinase, including the pectin methylesterase is not obtainable from potato, i.e. in one embodiment it is not a native pectin methylesterase; it is not a pectin methylesterase present naturally in potato; i.e. it is 15 not a wildtype potato pectin methyl esterase.

In the process of the invention, the pectin methylesterase treatment may be performed by contacting the potato pieces (or the potato dough/batter as the case may be) with a purified pectin methylesterase. The term "purified" as used herein 20 covers pectin methylesterase enzyme protein free from components from the organism from which it is derived. The term "purified" also covers pectin methylesterase enzyme protein free from components from the native organism from which it is obtained, which is also termed an "essentially pure" pectin methylesterase. The use of an "essentially pure pectin methylesterase" in the process of the invention 25 may be particularly relevant for pectin methylesterases identical to naturally occurring pectin methylesterase (such as potato pectin methylesterase), i.e. which have not been modified genetically by e.g. deletion, substitution or insertion of one or more amino acid residues.

- 30 Accordingly, the pectin methylesterase may be purified, viz. only minor amounts of other proteins being present. The expression "other proteins" relates in particular to other enzymes. The term "purified" as used herein also refers to removal of other

components, particularly other proteins and most particularly other enzymes present in the cell of origin of the pectin methylesterase. The pectin methylesterase may be "substantially pure", i.e. free from other components from the organism in which it is produced, i.e., e.g., a host organism for recombinantly produced pectin 5 methylesterase. Preferably, the enzymes are at least 75% (w/w) pure, more preferably at least 80%, 85%, 90% or even at least 95% pure. In a still more preferred embodiment the pectin methylesterase is an at least 98% pure enzyme protein preparation.

- 10 The term pectin methylesterase includes whatever auxiliary compounds that may be necessary for the catalytic activity of the enzyme, such as, e.g. an appropriate acceptor or cofactor, which may or may not be naturally present in the reaction system, divalent ions, such as alkaline earth ions, such as Ca^{2+} , e.g. in the form of calcium chloride.

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- The pectin methylesterase may be in any form suited for the use in question, such as e.g. in the form of a dry preparation, such as powder, granulate or a microgranulate, a non-dusting granulate, a liquid, a stabilized liquid, or a protected enzyme. Granulates may be produced, e.g. as disclosed in US 4,106,991 and US 4,661,452, 20 and may optionally be coated by methods known in the art. The enzyme may be stabilized in accordance with methods known in the art. Liquid enzyme preparations may, for instance, be stabilized by adding stabilizers such as a sugar, a sugar alcohol or another polyol, lactic acid or another organic acid according to established methods. Protected enzymes may be prepared according to the method disclosed in 25 EP 238,216. The enzyme may be dissolved in water or any suitable buffer system with or without addition of Ca^{2+} .

Further process steps:

- In one embodiment of the invention, the process further comprises the step of 30 blanching the potato pieces. Preferably, the blanching is performed prior to treatment of the surface of the potato pieces with pectin methylesterase. Thus, in one embodiment of the invention, the process compromises the steps of: i) blanching

potato pieces; and ii) treating the blanched potato pieces with pectin methylesterase. The blanching may be done in accordance with well-known procedures. Such procedures are exemplified e.g. in U.S 4,254,153 and "Effect of Preheating on Potato texture by A. Andersson et al., Critical Reviews in Food Science and Nutrition, 1994, 5 34 (3; 229-251)". The blanching may e.g. be performed by heating the potato pieces in an aqueous solution, including pure water. Typically for about 10 minutes at 75°C, such as in the range 70°C-100°C for 2-15 minutes or at 75°C-90°C for 4-10 minutes. Alternatively, the strips may be blanched in steam, such as at atmospheric pressure for e.g. about 2-10 minutes. The pectin methylesterase treatment may also be 10 performed during the blanching step and in this case the enzyme is to be enzymatically active during the conditions used for the blanching step.

In further embodiments, the potato pieces are partially dried after the pectin methylesterase treatment, such as e.g. by drying in hot air at e.g. 100-300°C for 5-20 15 minutes. Thus, before frying, i.e. after the enzyme treatment, the potato pieces may be drained and partly dehydrated to reduce their moisture content. Any of the conventional drying procedures used in the production of potato products, including french fries, may be used, such as, for example, subjecting the potato strips to heated air having a temperature of from about 40°C to about 200°C for about 2-20 20 minutes in order to reduce the moisture content of the strips to the point at which the strips have lost, e.g., about 5% to 30% of their initial weight.

In one embodiment, the blanched strips, after the enzyme treatment and prior to dehydration, are immersed in a dilute aqueous solution containing a food grade 25 sequestering agent, such as sodium acid pyrophosphate (SAPP) and a reducing sugar, such as dextrose or glucose. SAPP, present at a level of e.g. about 0.5% to 1.5%, may minimize product discolouration by chelating metal ions such as iron and copper present in the processing water. Dextrose or other reducing sugar in the aqueous solution facilitates uniform colour development upon frying.

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In one embodiment of the invention, the drying step is followed by a "resting step" in which the potato pieces is cooled down by standing at lower temperature, such as at

ambient temperature, for a while. The potato pieces may be cooled down to at least about 40°C before being fried. The resting step may consist in incubating the potato pieces at ambient temperature for about 5-10 minutes such as about 8 minutes.

- 5 The process according to the invention may further comprise the step of parfrying the pectin methylesterase treated potato pieces. In further embodiments, the process of the invention comprises the step of frying the pectin methylesterase treated potato pieces so as to be ready for consumption, with or without first parfrying the pectin methylesterase treated potato pieces. In one embodiment of the invention, the
- 10 process further comprises the step of freezing the pectin methylesterase treated potato pieces which may or may not have been parfried before freezing. The process of the invention may comprise a step for making the potato product ready for consumption such as potato product ready for consumption by baking in an oven or frying.

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Thus, within the scope of the invention is a process as described herein, wherein the potato product is french fries ready for consumption or wherein the potato product is frozen french fries which have been parfried before freezing.

- 20 Thus, the partially dehydrated potato pieces may be par-fried by immersing them in a deep fat fryer for a short period of time, for example, 20 to 240 seconds at a fat temperature of e.g. about 150°C-220°C. After par-frying, the potato strips may be frozen, packaged and shipped or stored for subsequent use. To prepare the par-fried strips for consumption, they fried in a deep fat or oil bath, for example, at a
- 25 temperature of from about 150°C to 220°C for 1 to 10 minutes to develop colour and crispiness.

Any of the conventional frying fats and oils may be used for frying the enzyme treated potato material in accordance with the invention. Such fats and oils includes, but are
30 not limited to, animal, vegetable and marine fats and oils, such as, e.g. lard, tallow, cottonseed oil, corn oil, soy bean oil, coconut oil, palm oil, whale oil, partially

hydrogenated fats and oils and similar such as glycerides having from, e.g. about 12 to about 22 carbon atoms in the molecule.

While the invention has been particularly described with respect to frying of the 5 frozen par-fried potato strips, it will be understood that potato strips which have been processed in accordance with the present invention and par-fried may, if desired, be prepared for consumption by other conventional procedures such as, for example, oven baking and microwave heating.

10 The potato strips may be treated with pectin methylesterase in accordance with the present invention and frozen without being par-fried. Thus, potato pieces may be blanched and contacted with an aqueous solution containing pectin methylesterase. After contact with the aqueous solution the potato strips preferably are partially dehydrated, to effect a weight loss of e.g. between 5% to 25%, after which the potato 15 strips are frozen. To reconstitute the frozen strips for consumption they are fried e.g. in a deep fat or oil bath at a temperature of between 150°C to 220°C. Since the frozen strips which have not been par-fried have a higher moisture content than par-fried strips, they are preferably fried for a slightly longer period of time, typically 4 to 10 minutes or between about 4 to 8 minutes. The specific time-temperature 20 conditions for frying the frozen strips to be ready for consumption, are, of course, a function of the cut size of the potato strips, and can be readily determined by those skilled in the art.

One embodiment of the invention relates to a process for the manufacturing of a 25 potato product comprising the steps of:

- i) blanching potato pieces;
- ii) treating the blanched potato pieces with pectin methylesterase; and
- iii) parfrying or deep frying the pectin methylesterase treated potato; optionally freezing the potato after step iii).

The invention also relates to a process for the manufacturing of a potato product, comprising the steps of:

- i) blanching potato pieces;
 - ii) treating the blanched potato pieces with pectin methylesterase;
 - iii) parfrying the pectin methylesterase treated potato;
 - iv) freezing the potato pieces after step iii); and
- 5 v) making the potato product ready for consumption by baking in an oven or frying.

Furthermore, the invention provides a process for the manufacturing of potato chips, the process comprising the steps of: i) treating potato pieces in the form of potato slices with pectin methylesterase; and ii) parfrying the pectin methylesterase treated 10 potato slices.

Included is also a process for the manufacturing of potato chips, the process comprising the steps of: i) treating potato pieces in the form of potato slices with pectin methylesterase; and ii) frying the pectin methylesterase treated potato slices; 15 to obtain potato chips ready for consumption.

The process of the invention may further comprise the step of coating the potato pieces before, during and/or after the pectin methylesterase treatment. The treatment of the surface of the potato pieces after the coating is particularly relevant in cases 20 where a pectin-containing coating has been used. The coating may be any coating found suitable, such as e.g. a hydrocolloid coating and/or a starch-based coating. The coating may be performed by any coating techniques known in the art. The coating may comprise pectic substances. The coating material may have been subjected to a treatment with pectin methyl esterase or another pectinase as 25 described herein.

The process of the invention may also further comprise the step of treating the potato pieces with a starch degrading enzyme, such as, an alpha-amylase before, during or after the pectin methylesterase treatment.

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As already described herein, the invention also relates to a process for the manufacturing of a potato product, the process comprising the steps of:

- (i) treating a potato batter or a potato dough with pectin methylesterase; and
 - (ii) processing the potato batter or potato dough into potato pieces of a desired shape.
- 5 This embodiment may be combined with any of the process steps as described herein with the appropriate accommodations which will be clear for the person skilled in the art as compared to a process as described where it is the surface of the potato pieces which are treated with pectin methylesterase. Thus, this embodiment may further comprises the step coating the potato pieces made from the potato dough or
- 10 potato batter. In one embodiment the coating comprises pectic substances and the process further comprise the step of treating the coating with a pectin methyl esterase after during coating.

Further embodiments:

- 15 The invention further relates to use of a pectinase enzyme preparation, such as e.g. a pectin methylesterase enzyme preparation, for the manufacturing of a potato product, in particular for the manufacturing of a potato product produced by any of the methods as described herein. The invention further relates to the use of pectin methylesterase for the manufacturing of a pectin methylesterase enzyme preparation
- 20 for use in potato processing, which enzyme preparation may be further modified (e.g. diluting in an aqueous solution) before the enzymatic treatment of the potato material. In particular the invention relates to use of pectin methylesterase for the manufacturing of a pectin methylesterase enzyme preparation for use in a process as described herein. The term "pectin methylesterase enzyme preparation" as used in
- 25 this context thus also encompasses any preparation comprising one or more pectin methylesterases, which preparation is manufactured and/or sold with the intention to be used in the process as described herein.

The invention also relates to potato product obtainable or obtained by the process of

30 the invention, i.e. by the process as disclosed herein.

By the present invention is provided a potato product, having improved properties as compared to a similar process without the treatment with pectin methylesterase. Accordingly, by the present invention is provided a potato product, wherein the crispiness of the resulting potato product ready for consumption is increased

5 compared to a similar process without the treatment with pectin methylesterase. Furthermore, it is contemplated that the resulting potato product ready for consumption remains crispy for an extended period of time compared to a similar process without the treatment with pectin methylesterase. Thus, the fried potato strips of this invention ready for consumption remain crisp for a longer period of time.

10 As already described herein instead of a pectin methylesterase other pectinases may be used to provide the desired product

The present invention is further illustrated in the following examples which is not to be in any way limiting to the scope of protection.

15

EXAMPLE

Example 1 Pectin methylesterase treatment of french fries.

2 kg of Bintje potatoes were peeled and cut into 10mm x 10mm elongated strips by
20 use of a kitchen french fry cutter (Westmark küchenhelfer).

The cut potatoes were blanched in batches of 500 g potato in 1500 ml water at 75°C for 10 minutes.

25 400 g of the blanched potato pieces where immersed in 1000 ml enzyme solution for 1 hour at 25°C. The enzyme solution was made by adding 5 g of NovoShape™ (Novo Nordisk A/S) to 1000 ml of a 0.25mM CaCl₂ solution. NovoShape™ is a monocomponent pectin methylesterase enzyme product derived from *Aspergillus aculeatus*. NovoShape™ has an activity of 10PEU/g. One PEU is defined as the
30 enzyme activity which creates one millimole acid equivalents per minute from methylated pectin at standard incubation conditions in a titrator. The standard conditions are pH 4.8, 0.48% substrate solution (the substrate is citrus pectin from

Copenhagen Pectin, Denmark, with % DE 69.2, %AGU 79.6, Mw 10200 and 89.72% dry matter, dissolved in 10mM MgCl₂, adjusted to pH 4.8), 30.0 °C and 2 minutes reaction time. The titrant, which is used to determine the amount of millimole acid equivalents produced by the enzyme, is 0.050 N NaOH .

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Another 400 g of the blanched potatoes were immersed in 1000 ml 0.25mM CaCl₂ solution for 1 hour at 25°C.

Next, the potato pieces were drained and placed in an oven at 130°C for 7 minutes to
10 dry. After drying, the potato pieces rested at room temperature for 8 minutes before
frying for 2 minutes in 195°C corn oil in a deep fryer from DANKOK, Model ELT 8B.
The par-fried and drained potato pieces were frozen at -18°C.

The frozen potato pieces were fried approximately 5 minutes in 195°C corn oil in the
15 deep fryer from DANKOK, Model ELT 8B until satisfactory colour was obtained. The
two batches of differently treated potato pieces (with and without pectin
methylesterase) were fried simultaneously in two different nets immersed in the deep
fryer.

20 Immediately after frying the two different batches of french fries were served for 13
persons who were asked to indicate which of the two samples (with random
numbering) was the most crisp. 9 out of the 13 persons chose the pectin
methylesterase treated french fries as being most crisp.

25 This example show that pectin methylesterase, when added to potato pieces,
increases the crispiness of the potato pieces after deep frying.

CLAIMS

1. A process for the manufacturing of a potato product, the process comprising the step of treating potato pieces with a pectinase, such as e.g. pectin methylesterase, wherein the enzyme is added to the potato pieces.
2. A process for the manufacturing of a potato product, the process comprising the step of treating potato pieces with an exogenic pectinase, such as e.g. an exogenic pectin methylesterase.
3. A process for the manufacturing of a potato product, the process comprising the step of treating potato pieces with a pectinase enzyme preparation, such as e.g. a pectin methylesterase enzyme preparation.
4. A process for the manufacturing of a potato product, the process comprising the step of treating potato pieces with pectinase, such as e.g. pectin methylesterase, wherein the enzyme treatment is performed by contacting the potato pieces with an aqueous solution comprising the enzyme.
5. The process according to any of the preceding claims, further comprising the step of blanching the potato pieces prior to the enzymatic treatment.
6. A process for the manufacturing of a potato product, the process comprising the steps of: i) blanching potato pieces; and ii) treating the blanched potato pieces with pectinase, such as e.g. pectin methylesterase.
7. The process according to any of the preceding claims, followed by partially drying the potato after the enzymatic treatment.
8. The process according to claim 7, further comprising a resting step after drying.

9. The process according to any of the preceding claims, further comprising the step of parfrying the pectinase treated potato pieces.

10. The process according to any of the preceding claims, followed by the step of
5 freezing the potato pieces, optionally without parfrying the potato pieces before
freezing.

11. The process according to any of claims 1-8, followed by the step of parfrying
the potato pieces and freezing the parfried potato pieces.

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12. The process according to any of the preceding claims, followed by the step of
frying the potato pieces.

13. The process according to claim 11, further comprising the step of making the
15 potato product ready for consumption by baking in an oven or frying.

14. A process for the manufacturing of a potato product comprising the steps of:

- i) blanching potato pieces;
- 20 ii) treating the blanched potato pieces with pectinase, such as e.g. pectin methylesterase; and
- iii) parfrying or deep frying the pectinase treated potato;
optionally freezing the potato after step iii).

25 15. A process for the manufacturing of a potato product, comprising the steps of:

- i) blanching potato pieces;
- ii) treating the blanched potato pieces with pectinase, such as e.g. pectin methylesterase;
- iii) parfrying the pectin methylesterase treated potato;
- 30 iv) freezing the potato pieces after step iii); and
- v) making the potato product ready for consumption by baking in an oven or frying.

16. A process for the manufacturing of potato chips, the process comprising the steps of: i) treating potato pieces in the form of potato slices with pectinase, such as e.g. pectin methylesterase; and ii) parfrying the pectinase treated potato slices.

5 17. A process for the manufacturing of potato chips, the process comprising the steps of: i) treating potato pieces in the form of potato slices with pectinase, such as e.g. methylesterase; and ii) frying the pectinase treated potato slices; to obtain potato chips ready for consumption.

10 18. The process according to any of the preceding claims, further comprising the step of coating the potato pieces.

19. The process according to claim 18, wherein the coating is a hydrocolloid coating and/or a starch-based coating.

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20. The process according to any of the preceding claims, wherein the pectinase treatment is performed during the blanching step.

21. The process of any of the preceding claims, wherein the potato pieces are obtained by dividing potatoes.

22. The process of any of the preceding claims, wherein the potato pieces are made from a potato dough or potato batter.

25 23. The process according to any of the preceding claims, further comprising the step of treating the potato pieces with a starch degrading enzyme, such as, an alpha-amylase.

24. The process according to any of the preceding claims, wherein the potato product is a fried potato product.

25. The process according to any of the preceding claims, wherein the potato product is an oven baked potato product.

26. The process according to any of claims 1-15 or any of claims 18-25, wherein
5 the potato product is french fries.

27. The process according to any of claims 1-15 or any of claims 18-25, wherein the potato product is french fries ready for consumption or wherein the potato product is frozen french fries which have been parfried before freezing.

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28. The process according to any of claims 1-25, wherein the potato product is potato chips.

29. The process according to claim 14 or 15, wherein the potato product is potato
15 strips, including french fries.

30. The process according to any of the preceding claims, wherein the crispiness of the resulting potato product ready for consumption is increased compared to a similar process without the treatment with the pectinase, such as e.g. the pectin
20 methylesterase.

31. The process according to any of the preceding claims, wherein the resulting potato product ready for consumption remains crispy for an extended period of time compared to a similar process without the treatment with pectinase, such as e.g.
25 pectin methylesterase.

32. The process according to any of the preceding claims, wherein the pectinase, such as e.g. the pectin methylesterase, is derived from a microbial organism, e.g., from a filamentous fungi, a yeast or a bacterium.

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33. The process according to claim 32, wherein the pectinase, such as e.g. the pectin methylesterase, is derived from a filamentous fungi .

34. The process according to claim 33, wherein the pectinase, such as e.g. the methylesterase is derived from *Aspergillus*.

35. The process according to any of the preceding claims, wherein the pectinase 5 (e.g. by a pectin methylesterase) treatment is performed by contacting the potato pieces with an aqueous solution comprising the pectinase.

36. The process according to any of the preceding claims, wherein the pectinase (e.g. a pectin methylesterase) treatment is performed by contacting the surface of the 10 potato pieces with the pectinase.

37. A process for the manufacturing of a potato product, the process comprising the steps of:

- (i) treating a potato batter or a potato dough with pectinase, such as e.g. 15 pectin methylesterase; and
- (ii) processing the potato batter or potato dough into potato pieces of a desired shape.

38. The process according to claim 37, further comprising a step of (iii) partially 20 drying the potato pieces after step (ii), optionally followed by a resting step (iv) before frying.

39. The process according to claim 37 or 38, further comprising, after step (ii), (iii) or (iv) as the case may be, a step of frying the potato pieces to be ready for 25 consumption.

40. The process according to any of claims 37-39, further comprising a step of parfrying the potato pieces.

30 41. The process according to any of claims 37-40, further comprising a step of freezing the potato pieces.

42. The process according to any of claims 37-41, further comprising the step of making the potato product ready for consumption by baking in an oven or frying.
43. The process according to any of claims 37-42, further comprising any of the 5 steps according to claims 18-19, and 23.
44. The process according to any of claims 37-43, wherein the pectinase is as defined in any of claims 2-3 or claims 32-35.
- 10 45. The process according to any of claims 37-43, wherein the potato product is as defined in any of claims 24-31.
46. The process according to any of claims 1-45, wherein the pectinase is selected from the group consisting of pectin methylesterase, pectin acetylesterase, 15 rhamnogalacturonan acetylesterase, arabinanase, galactanase, arabinofuranosidase, rhamnogalacturonase and rhamnogalacturonan lyase, pectate lyase, pectin lyase, and polygalacturonase.
47. The process according to any of claims 1-45, wherein the pectinase is pectin 20 methylesterase.
48. Use of a pectinase enzyme preparation, such as e.g. pectin methylesterase enzyme preparation, for the manufacturing of a potato product.
- 25 49. Use according to claim 48, wherein the potato product is produced by a method according to any of claims 1-47.
50. Use of pectinase for the manufacturing of a pectinase enzyme preparation for use in potato processing, such as e.g. use of pectin methylesterase for the 30 manufacturing of a pectin methylesterase enzyme preparation for use in potato processing.

51. Use of pectinase for the manufacturing of a pectinase enzyme preparation for use in a process according to any of claims 1-47, such as e.g. use of pectin methylesterase for the manufacturing of a pectin methylesterase enzyme preparation for use in a process according to any of claims 1-47.

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52. A potato product obtainable or obtained by the process of any of claims 1-47.

53. A process for the manufacturing of a potato product, the process comprising the step of treating potato pieces with a pectinase, which enzyme is capable of providing that the crispiness of the resulting potato product ready for consumption is increased compared to a similar process without the treatment with the pectinase.

54. A coating composition comprising a pectinase, such as e.g. a pectin methyl esterase.

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ABSTRACT

There is provided a process for producing fried potato strips or frozen potato strips for frying, including french fries, potato chips and related products wherein potato pieces are treated with a pectin modifying enzyme preparation to obtain a crispy surface after frying. An example of such pectin modifying enzyme is pectin methylesterase. The process of the invention may also provide a reduced fat uptake during frying and the fried strips retaining their crispiness for an extended period of time.